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Phragmites Management at Times Beach, Buffalo, New York

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PURPOSE: The purpose of this work was to evaluate the efficacy of mechanical cutting and herbicide applications to control invasive phragmites at Times Beach, a 56-acre nature preserve located in Buffalo, New York. The overall objective of this five-year project is to replace the dense monotypic stands of phragmites with a diverse native plant community that will repair ecosystem function.

BACKGROUND: Times Beach, located in Buffalo, New York, is a 56-acre preserve situated adjacent to the Buffalo River Area of Concern (AOC) and within the Niagara River Bi-national AOC. In 1971, the U.S. Army Corps of Engineers (USACE) began using the tract as a confined disposal facility (CDF) to dump soil dredged from the Inner Harbor, Buffalo River, and Back Rock canal. Although dumping continued over the next five years, the site attracted a variety of fish, plant, and bird species. In 1976, the Ornithological Society of Buffalo requested that the USACE Buffalo District partially fill and close the CDF.

Times Beach consists of three distinct ecological zones (aquatic, wetland, and upland) that are utilized by more than 200 species of resident and migratory birds (Andrie 1986, Summers and Lee 1997). The New York State Department of Environmental Conservation has designated approximately 46 acres of wetland habitat as a state wetland. The site is currently dominated by invasive species such as phragmites (*Phragmites australis* (Cav.) Trin. ex Steud.), Japanese knotweed (*Fallopia japonica* (Houtt.) Ronse Decr.), common buckthorn (*Rhamnus cathartica* L.), and mugwort (*Artemisia vulgaris* L.). In 2012, the U.S. Environmental Protection Agency (EPA) Great Lakes Restoration Initiative (GLRI) initiated and funded a Times Beach management and restoration plan that addressed the primary goals of invasive species removal and enhancement of native plant communities. Although there are four problematic species addressed in the management and restoration plan, this paper only discusses the phragmites infestation within the wetland zone.

Phragmites is a warm-season perennial grass that is found on every continent except Antarctica (Marks et al. 1994). In North America, 13 haplotypes have been identified of which 11 are native (Saltonstall 2002). The most expansive U.S. populations occur along the Atlantic Coast, the Mississippi Delta, and the Great Lakes region (Chambers et al. 1999; Kay 1995). These rapidly expanding populations are attributed to haplotype M, a non-native strain (Saltonstall 2002). Although not genetically tested, the phragmites present at Times Beach is most likely haplotype M, which is a highly invasive genotype prevalent in the Midwest and Northeast (Saltonstall 2002). Phragmites spreads by seeds, runners, and rhizomes (horizontal and vertical); and can inhabit a variety of habitats including fresh, brackish, alkaline, acidic and some tropical wetlands (Cross and

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Fleming 1989; Marks et al. 1994; Blossey and McCauley 2000). It is also common in areas like Times Beach where dredge material has been spread (Derr 2008a).

Phragmites typically grows in dense, monospecific stands which have a negative effect on many wetland species. Not only does phragmites shade out native plant species, but the dense aboveground shoot litter and the extensive belowground rhizomatous layer prevent more desirable plants from establishing (Marks et al. 1994). Dense stands of phragmites have decreased the natural plant biodiversity in many areas, thereby reducing waterfowl use (Blossey and McCauley 2000). According to Benoit and Askins (1999), "unbroken, monotypic stands of tall, emergent vegetation are generally considered low quality breeding habitat [*sic*] compared to mixed vegetation stands with many openings in the canopy." Resource managers employ a variety of management techniques to control phragmites, including mechanical control, burning, and chemical control. From 2005-2009, the U.S. spent more than $4.6 million on phragmites control, primarily via herbicides (Martin and Blossey 2013).

The purpose of the current work is to evaluate mechanical cutting and herbicide applications to control phragmites at Times Beach; however, the overall objective is to replace dense monotypic stands of phragmites with a diverse native plant community that will repair ecosystem function. The invasive species management and restoration of Times Beach is a five-year plan, which will include native plant establishment once large-scale phragmites management has been completed.

MATERIALS AND METHODS:

Management. A schedule of management activities at Times Beach is listed below in Table 1. The New York Department of Environmental Conservation (NYDEC) does not allow management activities to take place during spring migratory and breeding bird seasons (April 1 through August 31), which limits all management activities to the fall.

Table 1. Schedule of phragmites management and monitoring activities at Times Beach.

Year	Date	Activity
Year 1	Aug 7-8, 2012	Baseline vegetation monitoring
	Nov 8-9, 14-16, 2012	Cutting
Year 2	Jun 26-27, 2013	Vegetation monitoring
	Sept 23-25, 2013	Herbicide application
	Nov 4-6, 2013	Cutting
Year 3	June 25, 2014	Vegetation monitoring
	Sept 8-10, 2014 Oct 14, 2014	Herbicide application
	Nov 4-7, 11, 2014	Cutting

The wetland area of Times Beach was divided into three treatment areas (TA) that were 7.9, 9.4, and 7.5 acres, respectively (Figure1). An herbicide permit was not obtained in enough time to conduct an herbicide application in September 2012. In November 2012 and 2013, all three TAs were cut using an amphibious vehicle equipped with a tow behind mower. In September 2013, TA1 was treated with 2% glyphosate alone, TA2 was treated with a combination of 1% glyphosate plus 2% imazamox, and TA3 was treated with 4% imazamox alone. A non-ionic surfactant was added to the glyphosate treatment at

a rate of 0.5% v:v, and a methylated seed oil was added to the combination treatment and imazamox alone at a rate of 1% v:v. Treatments were applied using an amphibious vehicle equipped with a spray tower and boom. Additional herbicide treatments and cutting were conducted in the fall of 2014 on the same three TAs using the methods described above.

Figure 1. Map of Times Beach showing the position of each treatment area (TA) and transects (blue lines).

Monitoring. Two permanent transects were established within each TA for vegetation monitoring and survey techniques (Figure 1). The first and last three meters of each transect were skipped when collecting data. Mean percent cover of all species was determined along each transect using line intercept techniques. A 3 ft x 1.5 ft (0.91 m x 0.46 m) quadrat was placed at 5 ft intervals along each transect (alternating between the right and left side of the transect), and percent cover of each species was recorded. Percent cover was visually estimated using the following cover class values: 1-5%, 6-25%, 26-50%, 51-75%, 76-95%, and 96-100%. The mean value for each cover class was used for statistical analysis (i.e., 2.5, 15, 37.5, 62.5, 85, and 97.5). Data analyses used in the present study are similar to Daubenmire (1959).

For data analysis, all non-phragmites species (both native and non-native) were combined and referred to as "other species" (Table 2). Mean percent cover, ± 95 percent confidence intervals, were calculated for each TA.

Table 2. The most common "other species" found at Times Beach.		
Common Name	**Scientific Name**	**Native**
Garden yellow rocket	*Barbarea vulgaris* W. T. Aiton	N
Canada Thistle	*Cirsium arvense* (L.) Scop.	N
Spikerush sp.	*Eleocharis* sp.	Y
Rush sp.	*Juncus* sp.	Y
Purple loosestrife	*Lythrum salicaria* L.	N
Wild mint	*Mentha arvensis* L.	N
Smartweed sp.	*Persicaria* sp.	Y
Broad-leaved cattail	*Typha latifolia* L.	Y
Stinging nettle	*Urtica dioica* L. ssp *dioica*	N

RESULTS AND DISCUSSION:

Baseline data collected in summer 2012 was used to characterize the site (Table 3). Phragmites and cattail were the two most dominant species with few other species encountered in the TAs.

Table 3. Percent cover (± SE) of phragmites and cattails, and the number of other species was recorded at Times Beach in summer 2012 prior to management activities.			
	Phragmites % Cover	**Cattails % Cover**	**# of other species present**
Treatment Area 1	14.9 ± 1.9	15.9 ± 0.4	8
Treatment Area 2	46.1 ± 1.4	5.5 ± 1.6	3
Treatment Area 3	12.5 ± 10.6	24.5 ± 8.0	3

Phragmites was mechanically cut in fall 2012, and in fall 2013 was treated with herbicide and mechanically cut again. Following treatments in 2013, monitoring data collected June 2014 documented reductions in phragmites cover and an increase in other species present (Table 4). Treatments were not conducted in the large cattail stands, so only phragmites data are presented. The percent cover of phragmites in TA1 was significantly greater compared to TA2, but was not different from TA3. There was no difference between TA2 and TA3. The number of other species encountered along the transects was greater than that seen in 2012 indicating the presence of a large seedbank. Removal of phragmites aboveground biomass (living material plus detrital biomass) allowed maximum light penetration and heat accumulation on the soil surface, thus encouraging sprouting of other species during the growing season. Refer back to Table 2 for a list of the 10 most common other species.

Table 4. Percent cover (± 95% confidence intervals) of phragmites in each treatment area of Times Beach was recorded in June 2014 following two cutting events and one herbicide application. The number of other species in each treatment area was also recorded.			
	Treatment	**Phragmites % Cover**	**# of other species present**
TA1	Glyphosate + Cutting	0.82 ± 0.13	20
TA2	Glyphosate/Imazamox + Cutting	0.22 ± 0.00	14
TA3	Imazamox only	0.82 ± 2.67	15

Numerous authors have documented the efficacy of glyphosate on phragmites (Kay 1995; Derr 2008a; Derr 2008b; Mozdzer et al. 2008; True et al. 2010). Glyphosate applications have also been successfully used in conjunction with cutting (Monteiro et al. 1999; Moreira et al. 1999) and burning (Ailstock et al. 2001). Monteiro et al. (1999) found that cutting phragmites in the fall followed by a spring herbicide application significantly improved herbicide efficacy. Although herbicide and cutting both occurred in the fall at Times Beach, fall cutting in all likelihood reduced standing biomass and may have affected the accumulation of carbohydrate reserves in the rhizomes, leading to a reduction in spring regrowth (Monteiro et al. 1999; Moreira et al. 1999).

Imazapyr is not registered for aquatic use in New York State (NYSDEC 2012), therefore imazamox was chosen for this project. Imazamox was registered for use in aquatic sites in 2008 (Netherland 2014), and few studies have documented its effectiveness on phragmites. A container study reported that imazamox had a growth regulating effect instead of a mortality effect (Cheshier et al. 2012), and True et al. (2010) reported approximately fifty percent control in field trials. At Times Beach, imazamox was just as effective alone as glyphosate alone. Likewise, it is just as effective as the imazamox and glyphosate combination. The studies by Cheshier et al. (2012) and True et al. (2010) evaluated imazamox alone, whereas at Times Beach the phragmites was cut following herbicide application and could be the reason for improved control. No literature could be found on the effectiveness of a glyphosate-imazamox combination alone or in conjunction with cutting on phragmites.

Multiple years of treatment are planned for Times Beach because eighty percent of phragmites biomass is produced underground in the roots and rhizomes (Holm et al. 1977), and rhizomes can live for three to six years (Marks et al. 1994). As with similar studies, some regrowth of phragmites was observed during the 2014 growing season (Derr 2008a; Derr 2008b; Monteiro et al. 1999; Kay 1995).

FUTURE WORK: The invasive species management and restoration of Times Beach is a five-year plan. In the remaining two years of the project, native species will be established while invasive species will continue to be controlled as necessary.

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